7. DEPENDENCY OF FAN-DRYING OF DARTERS *ANHINGA RUFA* AND LITTLE CORMORANTS *PHALACROCORAX NIGER* ON INCIDENT SUNLIGHT

(With one text-figure)

The spread-wing posture of cormorants and darters has long been the subject of scientific investigation (Kortlandt 1940, Clark 1969, Curry-Lindahl 1970). The main hypotheses in connection with this behaviour are that it is i. balancing posture (Stabler 1957); ii. intraspecific signal of successful fishing (Jones 1978); iii. aid to thermoregulation (Curry-Lindahl 1970, Hennemann 1982) or iv. wing drying strategy (Kortlandt 1940, Winkler 1983).

Strong support for the now generally accepted theory of wing-drying is provided by the fact that the plumage of both the cormorant and the darter is water absorbent for efficient underwater swimming through reduced buoyancy (Ruke 1968, Siegfried *et al.* 1975, Hennemann 1984). On the assumption that the spread-wing posture, which enlarges the area for absorption of solar radiation, does serve to dry the wings, the question arises: How do the birds dry their wings in the shade, or in the absence of direct sunlight? This study analyzes behavioural adaptation in these circumstances.

The study was carried out in the Keoladeo National Park, Bharatpur, Rajasthan, India. The area has a typical dry tropical monsoon climate (Ewans 1989, Scott 1989). Observations of spread-wing behaviour of little cormorants *Phalacrocorax niger*, and darters *Anhinga rufa,* were made from October 26 to November 2, 1990, during calm weather. Binoculars (10x40) and a compass were used to determine the orientation of the birds to incident sunlight. Birds were noted as being exposed to the sun or as sitting in the shade: periods when there was no sun (before sunrise and after sunset) were also noted. Steady spread-wing posture and active fanning ("fan-drying") spread-wing posture were treated as separate. Ambient temperature was measured with a black thermometer (bimetal) in direct sunlight. Statistical analyses of the birds' orientation to the sun followed standard methods (Schmidt-Koenig 1975, Fowler and Cohen 1986, Brown and Downhower 1988).

Spread-wing behaviour was shown by both species during daylight, mainly in the available direct solar radiation, which facilitates wing drying. The orientation of birds sitting or perching was not random, as the alignment of their backs and wing surfaces showed a highly significant correlation towards the sun (Rayleigh's test (Schmidt-Koenig 1975): $a = 0.67$; $p<0.01$; $n = 70$ for the little cormorant; $a = 0.84$; $p<0.01$; $n = 38$ for the darter). In the weak morning light before 0700hrs, and in the flat evening sun after 1700 hrs (Fig.1), only one cormorant and twenty-five darters (21.3% of 122 observations) showed the spread-wing posture.

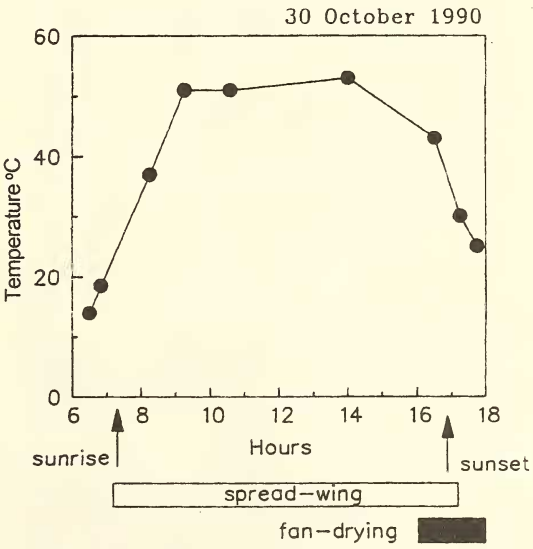

Fig. 1: Ambient temperature

Fan-drying was observed more frequently in the late afternoon than in the rest of the day. There were significant differences (χ^2 = 10.8; $p<0.01$; df = 1; n 30) for both species combined, between times before and after 1600 hrs. Fan-drying was also more frequent in the absence of incident sunlight (after sunset), as well as when birds were in the shade (χ^2 = 13.4; $p<0.01$; df = 1; n =27). A two by two contingency table χ^{2-} test showed highly significant (χ^2 = 52.1; $p<0.01$; df = 1; n = 111) associations between spread-wing posture and direct exposure to sùn, and fan-drying and no direct sun exposure.

Wing flap frequency during fanning was higher (t = 5.54; $p<0.01$; df = 64, Student's t-test) for the little cormorant at 3.3 beats per second (n = 14) than for the darter at 2.4 beats per second (n = 52).

There is now general agreement that sunning behaviour and the dark colour of the plumage of darters and cormorants serve to dry the wings (Simmons 1986). The spread-wing posture has, indeed, been described as the wing-drying posture in response to the "wings wet" stimulus (Kortlandt 1940). Darters and cormorants extract full advantage from the heat absorbing qualities of their black plumage by increasing the area exposed to the sun, thus facilitating evaporation (Lustick *et al.*1978, 1980). Wing-drying has been suggested, in the American darter *(Anhinga anhinga)*, as a rapid thermoregulatory mechanism for re-establishment of a layer of air next to the skin to conserve metabolic heat (Hennemann 1982). The drying function of the spread-wing posture of little cormorants in Sri Lanka as a means of regaining airworthiness has also been emphasized (Winkler 1983).

Several studies show that darters and cormorants orient to the wind when this is strong (Siegfried *et al.*, 1975, Hennemann 1984, Winkler 1983). Orientation to the wind can be interpreted as a strategy to relieve the bird of the necessity of fanning its wings (Kortlandt 1940). In the absence of windy conditions, however, most species orient themselves perpendicularly to the incident radiation *(Anhinga anhinga*: Hennemann 1982; *Phalacrocorax niger*, *P. fuscicollis*, *P. carbo*: Winkler 1983; *P. harrisi*, *P. auritus*: Hennemann 1984; *P. capensis*, *P. neglectus*, *P. lucidus*, *P. africanus*: Siegfried *et al.*, 1975). The results of the present study show a significant correlation of directional orientation to the sun in calm weather and thus confirm the importance of direct sunlight for heat absorption and wing-drying.

In contrast to the relative volume of literature on the spread-wing posture, fan-drying has been the subject of little study and is mentioned only anecdotally (e.g. Portielje 1927, Winkler 1983, Hennemann 1984, Simmons 1986). Fanning was not observed very often in the present study, but when it was, it was almost exclusively in the shade or after sunset. This strongly suggests that lack of solar radiation, which is necessary for drying the wings, is compensated for by the active convection induced by fanning. It had also been postulated elsewhere (Hennemann 1982) that *Anhinga* fan wings and tail in preference to holding them steady under conditions of low solar radiation. In addition, it was shown by van Rhijn (1977) that herring gulls (*Larus argentatus*) improved evaporation by actively shaking their feathers.

The higher frequency of wing flaps, of the little cormorant seems to be correlated with its smaller body size compared to the darter (cf. Campbell & Lack 1985).

ACKNOWLEDGEMENTS

The management of the Keoladeo Ghana National Park, and especially Bholu Khan,

are thanked for their administrative support and intellectual guidance. We also acknowledge the critical revision of a former draft of the manuscript as well as the correction of the English language by Dr. T. Wilson.

July 17, 2001

GERALD DICK
Institut für Öko-Ethologie, Altenburg 47, A-3573 Rosenburg, Austria
IRENE WÜRDINGER
Universität Hildesheim, Marienburger. Platz 22, D- 32 Hildesheim, Germany.

REFERENCES

BROWN, L. & J.F. DOWNHOWER (1988): Analyses in Behavioral Ecology. Sinauer. Assoc., Sunderland, Mass.

CAMPBELL, B. & E. LACK (eds.) (1985): A Dictionary of Birds. Poyser, Calton.

CLARK, G.A. (1969): Spread-wing postures in Pelecaniformes, Ciconiiformes, and Falconiformes. *Auk 86*:136-139.

CURRY-LINDAHL, K. (1970): Spread-wing postures in Pelecaniformes and Ciconiiformes *Auk 87*: 371-372.

EWANS, M. (1989): Bharatpur bird paradise. Witherby, London.

FOWLER, J. & L. COHEN (1986): Statistics for Ornithologists. BTO Guide No. 22, Tring.

HENNEMANN, W.W. (1982): Energetics and spread-winged behaviour of *Anhingas* in Florida. *Condor 84*: 91-96.

HENNEMANN, W.W. (1984): Spread-winged behaviour of double-crested and flightless cormorants *Phalacrocorax auritus* and *P. harrisi*: wing drying or thermoregulation? *Ibis 126*: 230-239.

JONES, P.A. (1978): A possible function of the 'wing-drying' posture in the Reed Cormorant *Phalacrocorax africanus*. *Ibis 120*: 540-542.

KORTLANDT, A. (1940): Eine Übersicht der angeborenen Verhaltungsweisen des Mittel-Europäischen Kormorans (*Phalacrocorax carbo sinensis* [Shaw & Nodd.]), ihre Funktion, ontogenetische Entwicklung und phylogenetische Herkunft. *Arch. Neerl. Zool. 4*: 401-442.

LUSTICK, S., B. BATTERBY & K. KELTY (1978): Behavioral thermoregulation: Orientation toward the sun in Herring Gulls. *Science 200*: 81-83.

LUSTICK, S., M. ADAM & A. HINKO (1980): Interaction between posture, color and the radiative heat load in birds. *Science 208*: 1052-1053.

PORTIELJE, A.F.J. (1927): Zur Ethologie bezw. Psychologie von *Phalacrocorax carbo subcormoranus* (Brehm). *Ardea 16*: 107-123.

RUKE, A.M. (1968): The water repellancy and feather structure of cormorants, Phalacrocoracidae. *J. Exp. Biol. 48*: 185-189.

SCHMIDT-KOENIG, K. (1975): Migration and Homing in Animals, Springer, Berlin, Heidelberg, New York.

SCOTT, D.A. (ed.)(1989): A Directory of Asian Wetlands, IUCN Gland.

SIEGFRIED, W.R., A.J. WILLIAMS, P.G.H. FROST, & J.B. KINAHAN (1975): Plumage and ecology of Cormorants. *Zool. Africana 10(2)*: 183-192.

SIMMONS, K.E.L. (1986): The sunning behaviour of birds, The Bristol Ornithological Club, Bristol.

STABLER, R. (1957): Cormorants and Shags "drying" their wings. *Brit. Birds 50*: 447-448.

VAN RHIJN, J.G. (1977): Processes in feathers caused by bathing in water. *Ardea 65*: 126-147

WINKLER, H. (1983): Das Flügelspreitverhalten der Mohrenscharbe *Phalacrocorax niger*. *J. Orn. 124*: 177-186.

8. WHITE STORKS *CICONIA CICONIA* ON MIGRATION

Migrating white storks *Ciconia ciconia* stop over to rest near Udayampatti village, about 5 km from Kalainzar Karunanidhi (KK) Nagar, Tiruchirapalli, Tamil Nadu. I have been seeing them here for the last 11 years. The area is roughly bounded by road from KK Nagar to Pudukkottai on the east, by the curving irrigation channel in the north and west. It extends to the south over and beyond the fallow and agricultural lands. A railway line runs parallel to the irrigation channel for some distance. The railway crossing, a roadside temple and tile factory chimneys far beyond in the southeast are unmistakeable landmarks. On the ground, the area appears as a loose rectangle, widening in the south, with a cart road running west to Vadugapatty. It is about 9 sq. km of mildly undulating, scrub jungle (about 30%) with grass